Green Growth Knowledge Platform (GGKP)
Third Annual Conference
Fiscal Policies and the Green Economy Transition: Generating Knowledge – Creating Impact
29-30 January, 2015
University of Venice, Venice, Italy

Drivers of investments in cleaner energy

Francesco Vona (OFCE Sciences-Pro)
Elena Verdolini (Fondazione Eni Enrico Mattei)

The GGKP's Third Annual Conference is hosted in partnership with the University of Venice, The Energy and Resources Institute (TERI) and the United Nations Environment Programme (UNEP).

GREEN GROWTH
Knowledge Platform

DRIVERS OF INVESTMENTS IN CLEANER ENERGY

Elena Verdolini, FEEM and Francesco Vona, OFCE Sciences-Po

To be socially acceptable, policies and regulation increasing technological availability need to be translated into substantial changes in energy production, as to lower CO_2 emissions. This is neither easy nor straightforward. First, absent environmental policy to internalize the negative pollution externality, most of the carbon free technological options available for energy production are not cost competitive with traditional fossil inputs. Second, the energy sector is characterized by long-lived capital stock and significant sunk investment in existing (fossil-fuel) plants, hence changes in electricity production are slow and dependent on the age of the capital stock. Third, even if low carbon technologies were cost-competitive with fossil, over-regulated energy markets may prevent access to the grid to renewable energy producers.

This paper studies the determinants of investments in both renewable and fossil electricity capacity in a panel of 27 OECD countries over the years 1977-2007. We focus on how technological availability, market structure and environmental policy affect the choices to install new renewable and efficient-fossil electricity production. This topic is of great relevance to assess whether OECD countries will be able to meet ambitious future environmental targets. Moreover, empirical evidence in this respect is rather scarce.

We contribute to the literature by extending the analysis of Popp et al. (2011) to include additional determinants of the investment decision. First, we account for market structure using the index of product market regulation, which measures the degree of entry barriers in electricity production at the country level. Entry of new players may have been essential to the diffusion of renewable energy as they involve decentralized energy generation (DG), smaller production scale and competences far from those of existing incumbents. Second, we improve on the measurement of environmental policy by building a single policy index, in line with Nicolli and Vona (2012). As already said, environmental policy can reduce the wedge between the costs of power production for the clean and dirty technologies, and is thus likely to play a key role in the decision to install new power capacity.

Moreover, unlike Popp et al. (2011), we analyze investment decisions both in renewable technologies and in fossil power production. First, renewable energy technologies, especially the most promising ones as Solar and Wind, are characterized by high intermittency and therefore rely on fossil fuel power production to compensate in cases of low production. In order to increase the cost-effectiveness of renewable energies, high efficiency fossil plants and technologies need to be installed because they can quickly be brought on and off line. As a result, analyzing the investment decision in renewable energy sources without accounting for these complementarities and for the need to upgrade old fossil based plants provides only limited policy insights. Second, fossil fuel and renewable investments can be substitute reflecting technological path-dependency that might lock-in a country in the centralized and dirty methods of energy production (Acemoglu et al. 2010). Overall, which of the two effects prevail is an empirical issue.

Data on capacity in renewable and fossil technologies comes from the IEA Electricity Information Database (2013) and patent data are extracted from KiTES (2010). Data on policies and market regulation are taken, respectively, from the IEA renewable energy dataset (see Nicolli and Vona 2012 for details) and the OECD. Additional controls include energy prices, electricity consumption, production of nuclear energy, GDP per capita, population and knowledge stocks.

The other main novelty of this paper is in the methodology used to estimates the effects of our main variables of interest. Popp et al. (2011) neglect the fact that data on both investments and energy capacity are censored at zero. In our main sample, around 40% of the observations are zeros. The inflation of zeros is even higher in new renewable energy, such as Wind, Solar, Geothermal, reaching 50% of the observations. The many zeros are in this case not the outcome of an unobservable selection process, but simply represent corner solutions of a rational decision at the country level, i.e. energy strategy. For renewable energy capacity, and observed zero denotes that costs and constraints overcome the benefits of these investments. We deal with these issues using a Random Effect Tobit model, adjusted using the Mundlak-Chamberlain procedure to allow positive correlation between the explanatory variables to the set of controls in a Random Effect Tobit model. We check the robustness of our results using also a Heckman two-stage procedure that, unlikely the Tobit method, allows correlated unobservable effects between the extensive (observing positive investments or not) and the intensive (how much investments are done) margins. Finally, we check the robustness of our results to different dependent variables: overall capacity, investments and investments made by auto-producers only. We also use installed capacity as dependent variable since investments are highly volatile and hence characterized by a larger unobservable random component. We estimate our model both using all the technologies together (geothermal, marine, solar, hydro, wind and fossil) and for each technology separately and results are substantially confirmed. Our results are also robust to both Heckman and Tobit methods. Finally, results do not seem to suffer from an incidental parameter problem as the panel we use is quite long.

Our main results are the following. First and foremost, our estimation method substantially changes the results obtained by Popp et al. (2011): when properly accounting for the issue of the zeros in the estimation procedure, the effect of the main policies of interest becomes significantly different from zero. Particularly large is the effect of feed-in tariffs and of the policy index, which includes tax, R&D and investment incentives, obligations and voluntary agreements. In turn, renewable energy certificates display a statistically insignificant effect. In our favourite specification, a 1% increase in feed-in tariffs lead to a more than 2% increase in the installed capacity, while the effect is smaller but still significant on investments. As expected, both the effect of feed-in and of the policy index are much stronger on wind and solar.

Second, the reduction in entry barriers plays a critical role in stimulating renewable energy investments. The positive effect of lowering entry barriers on the diffusion of cleaner capacity is consistent with case study evidence pointing to the key role of new entrants (e.g. Jacobsson and Bergek 2004). Importantly, part of the positive effect of lowering entry barriers on green investments is a lower bound as a lower market regulation positively affects both green policies and technologies (Nesta et al. 2012, Nicolli and Vona 2012). Interesting too, the effect of lower entry barriers is negative on investments in capacity using fossil sources. In general, the determinants of fossil fuel investments appear substantially different from the ones of investments in solar and wind. However, so far we did not distinguish brown fossil fuel sources (i.e. biomass, waste) from black ones (i.e. coal). We are currently extending the paper in this direction.

Third, the results are confirmed using capacity installed from autoproducers as dependent variable. In this case, results are less stable across specifications reflecting the very large number of zeros (over 70%). As expected, feed-in tariffs are even more important for autoproducers. Among the other determinants, it is interesting to note that both GDP per capita and larger expected electricity consumption spur capacity installation. Finally, including proxies for institutional quality to control for time-varying unobservable country effects does not affect our results, while the knowledge stocks is often statistically insignificant.

Our results suggest that feed-in tariff and low entry barriers in the electricity sector are the main drivers of renewable energy investments. This is coherent with the idea that key renewable energies (wind and solar) are interlocked to the distributed method of energy production. Not surprisingly then, big players dominating the EU market, e.g. EDF, ENI, E-ON, Vattenfall, strongly opposed feed-in tariffs. These big players clearly prefer policies that, such as renewable energy certificates, are less risky for the centralized paradigm of energy production. The differential effect of entry barriers on green and dirty investments is also particularly relevant from a policy perspective, but deserves further investigations.

References

Acemoglu, D., Aghion, P., Bursztyn, L., Hemous, D., (2010). The Environment and Directed Technical Change.NBER Working Paper 15451.

IEA (2013). Electricity Information Database.

Popp, D., Hascic, I., Medhi, N., (2011). Technology and the diffusion of renewable energy. Energy Economics 33, 648–662.

Jacobsson, S., Bergek, A., (2004). Transforming the Energy Sector: The evolution of technological systems in renewable energy technology. Industrial and Corporate Change 13, 815-849.

Johnstone, N., Hascic, I., Popp, D., 2010. "Renewable energy policies and technological innovation: evidence based on patent counts." Environmental and Resource Economics 45 (1), 133–155

KITeS. 2010. EP-KITeS Patent Database

Nesta, L., F. Vona and F. Nicolli 2012. "Environmental Policies, Product Market Regulation and Innovation in Renewable Energy", FEEM working paper.

Nicolli, F. and F. Vona, 2012. "The Evolution of Renewable Energy Policies in OECD countries: aggregate indicators and determinants", FEEM working paper.